36

1 Claims

2

- 3 1. A method of insulating a subsea structure, the 4 method comprising:
- 5 injecting a substance into the subsea structure;
- 6 allowing said substance to form a gel, wherein
- 7 the formed gel has a dynamic viscosity of more
- 8 than 1000Pa.S.

9

- 10 2. A method as claimed in claim 1, wherein the
- 11 formed gel has a dynamic viscosity of over 2000
- 12 Pa.S.

13

- 14 3. A method as claimed in either preceding claim,
- 15 wherein the substance comprises a hydrocarbon.

16

- 17 4. A method as claimed in any preceding claim,
- 18 wherein the formed gel retains its integrity
- 19 unsupported.

20

- 21 5. A method as claimed in any preceding claim,
- 22 wherein the substance is a pourable fluid prior to
- 23 forming the gel.

24

- 25 6. A method as claimed in any preceding claim,
- 26 wherein cenospheres or microspheres are added to the
- 27 substance.

28

- 29 7. A method as claimed in any preceding claim,
- 30 wherein spheres enclosing hydrocarbon gas are added
- 31 to the substance.

37

- 1 8. A method as claimed in any preceding claim,
- 2 wherein the substance comprises wax.

3

- 4 9. A method as claimed in claim 8, wherein the wax
- 5 is a highly branched chain wax.

6

- 7 10. A method as claimed in any preceding claim,
- 8 wherein the subsea structure comprises a conduit,
- 9 said conduit enclosing a second conduit.

10

- 11 11. A method as claimed in claim 10, wherein the
- 12 method comprises recovering hydrocarbons within the
- 13 second conduit.

14

- 15 12. A method as claimed in any claim 11, wherein
- 16 the gel is adapted to transfer a portion of the
- 17 hydrostatic pressure on the first conduit onto the
- 18 second conduit.

19

- 20 13. A method as claimed in any one of claims 10 to
- 21 12, wherein the thermal properties of the gel is
- 22 varied over the length of a conduit or series of
- 23 conduits.

24

- 25 14. A method as claimed in any preceding claim,
- 26 wherein the substance comprises a polymeric compound
- 27 and a transition metal salt.

28

- 29 15. A method as claimed in claim 14, wherein at
- 30 least one of the polymeric compound and transition
- 31 metal salt is encapsulated in wax.

38

1, 16. A method as claimed in claim 14 or claim 15,

2 wherein the polymeric compound comprises a

3 phosphate.

4

5 17. A method as claimed in claim 16, wherein the

6 phosphate comprises an orthophosphate.

7

8 18. A method as claimed in claim 17, wherein the

9 orthophosphate comprises an orthophosphate ester.

10

. 11 19. A method as claimed in claim 18, wherein the

12 orthophosphate ester has the structure according to

13 formula I:

14

15

17

18

. .

19 Formula I

20 wherein R is a straight or branched chain alkyl or

21 alkaryl group having about 6 to about 18 carbon

22 atoms and R' is hydrogen or an aryl, alkaryl or

23 alkyl group having about up to 18 carbon atoms.

24

25 20. A method as claimed in any one of claims 16 to

26 19, wherein about 0.3% to 3.0 wt% of the phosphate

27 is added to the substance.

28

29 21. A method as claimed in any one of claims 15 to

30 20, wherein the transition metal salt and polymeric

31 compound are added in an equimolar ratio.

l 22. A method as claimed in any one of claims 14 to

39

2 18, wherein the transition metal salt comprises a

3 ferric salt.

4

5 23. A method as claimed in claim 22, wherein the

6 ferric salt is selected from the group consisting of

7 ferric sulphate, ferric citrate, ferric ammonium

8 sulphate, ferric ammonium citrate, ferric chloride,

9 and ferric gluconate.

10

. 11 24. A method as claimed in any one of claims 1 to

12 13, wherein the substance comprises a first fluid

13 which has a relatively high specific heat capacity

14 and a second fluid which has a relatively low

15 thermal conductivity.

16

17 25. A method as claimed in claim 24, wherein the

18 first fluid is water and the second fluid is a

19 hydrophobic fluid, such as oil.

20

21 26. A method as claimed in claims 24 or 25, wherein

22 the substance comprises a first and a second

.23 polymeric compound, the first polymeric compound

24 having the general formula

25

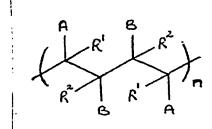
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31 wherein A and B are the same or different wherein at

32 least one comprises a relatively polar atom or group

- 1 and R<sup>1</sup> and R<sup>2</sup> independently comprise relatively non-
- 2 polar atoms or groups.

3

- 4 27. A method as claimed in claim 26, wherein R1 and
- 5 R<sup>2</sup> are selected form the group consisting of
- 6 hydrogen atoms and alkyl groups.

7

- 8 28. A method as claimed in any one of claims 26 to
- 9 27, wherein A and B are independently selected from
- 10 optionally-substituted alkyl, cycloalkyl,
- 11 cycloalkenyl, cycloalkynyl, aromatic and
- 12 heteroaromatic groups.

13

- 14 29. A method as claimed in claim 26 to 28, wherein
- 15 A represents a phenyl group substituted, preferably
- 16 at the 4-position relative to the group C-C, by a
- 17 formyl group or a group of general formula:

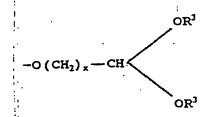
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22



- 23 wherein x is an integer from 1 to 6 and each  $R^3$  is
- 24 independently an alkyl or phenyl group or together
- 25 form an alkalene group.

26

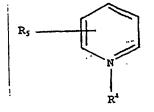
27 30. A method as claimed in any one of claims 26 to

X-

- 28 29, wherein group B represents a group of general
- 29 formula:

30

31



41

- 1 wherein R4 represents a hydrogen atom or an alkyl or
- 2 aralkyl group, R<sup>5</sup> represents a hydrogen atom or an
- 3 alkyl group and  $X^-$  represents a strongly acidic ion.

4

- 5 31. A method as claimed in any one of claims 26 to
- 6 30, wherein the second polymeric compound includes a
- 7 functional group selected from the group consisting
- 8 of an alcohol, carboxylic acid, carboxylic acid
- 9 derivative and an amine group.

10

- 11 32. A method as claimed in any one of claims 26 to
- 12 31, wherein the second polymeric compound is
- 13 selected from the group consisting of
- 14 polyvinylalcohol, optionally substituted
- 15 polyvinylalcohol, polyvinylacetate, polyalkalene
- 16 glycols and collagen.

17

- 18 33. A method as claimed in claim 32, wherein the
- 19 second polymeric compound is polyvinyl alcohol.

20

- 21 34. A method as claimed in any one of claims 26 to
- 22 33, wherein the substance furthers comprises a
- 23 catalyst to catalyse the reaction between the first
- 24 and the second polymeric compounds.

25

- 26 35. A method as claimed in claim 34, wherein the
- 27 catalyst is paratoluene sulphuric acid.

- 29 36. A method of insulating a submerged conduit, the
- 30 method comprising the steps of:
- applying at least one substance to the conduit
- 32 before it is submerged; then,

1	submerging the conduit under water; and
2	allowing the substance to form a gel with a
3	dynamic viscosity of more than 1000Pa.S.
4	
5	37. A method as claimed in claim 36, wherein the
6	tubular comprises further tubulars enclosed therein.
7	
8	38. A method of altering the buoyancy of a subsea
, 9	structure, the method comprising,
10	injecting a substance into the subsea structure;
11	allowing said substance to form a gel, wherein the
12	formed gel has a dynamic viscosity of more than
13	1000Pa.S.
14	•
15	39. A method as claimed in claim 38, wherein the
16	substance includes microspheres.